phenomenon simply suggests that the future will also have large variability, but does not negate overall climate trends, because the basic physics of climate processes, including sea ice albedo feedback, are modeled in all major sectors of the Arctic Basin. The increased understanding of the basic physics related to climate processes and the inclusion of these parameters in current climate models, such as those used in the IPCC AR4, present a more complete, comprehensive, and accurate view of range-wide climate change than earlier models.

Comment 27: Other models should be used in the analysis of forecasted environmental and population changes including population viability assessment and precipitation models.

Our response: The Service has not relied upon the published results or use of a single climate model or single scenario in its analyses. Instead we have considered a variety of information derived from numerous climate model outputs. These include modeled changes in temperature, sea ice, snow cover, precipitation, freeze-up and breakup dates, and other environmental variables. The recent report of the IPCC AR4 provides a discussion of the climate models used, and why and how they resulted in improved analyses of climatic variable and future projections. Not only have the models themselves been improved, but many advances have been made in terms of how the model results were used. The AR4 utilized multiple results from single models (called multi-member ensembles) to, for example, test the sensitivity of response to initial conditions, as well as averaged results from multiple models (called multi-model ensembles). These two different types of ensembles allow more robust evaluation of the range of model results and more quantitative comparisons of model results against observed trends in a variety of parameters (e.g., sea ice extent, surface air temperature), and provide new information on simulated statistical variability. This final rule benefits from specific analyses of uncertainty associated with model prediction of Arctic sea ice decline (DeWeaver 2007; Overland and Wang 2007a, pp. 1–7), and identification of those models that best simulated observed changes in Arctic sea ice.

We also updated this final rule with information on recently completed population models (e.g., Hunter et al. 2007), habitat values and use models (Durner et al. 2007), and population projection models (Amstrup et al. 2007), which can be found in the ''Current Population Status and Trend'' section.

Comment 28: Future emission scenarios are unreliable or incomplete and use speculative carbon emission scenarios that inaccurately portray future levels.

Our response: Emissions scenarios used in climate modeling were developed by the IPCC and published in its Special Report on Emissions Scenarios in 2000. These emissions scenarios are representations of future levels of GHGs based on assumptions about plausible demographic, socioeconomic, and technological changes. The most recent, comprehensive climate projections in the IPCC AR4 used scenarios that represent a range of future emissions: low, medium, and high. The majority of models used a ''medium'' or ''middle-of-the-road'' scenario due to the limited computational resources for multi-model simulations using GCMs (IPCC 2007, p. 761). In addition, Zhang and Walsh (2006) use three emission scenarios representative of the suite of possibilities and DeWeaver (2007 p. 28), in subsequent analyses, used the A1B ''business as usual'' scenario as a representative of the medium-range forcing scenario, and other scenarios were not considered due to time constraints. Similarly, our final analysis considered a range of potential outcomes, based in part on the range of emission scenarios. For additional details see the previous section, ''Projected Changes in Arctic Sea Ice.''

We agree that emissions scenarios out to 2100 are less certain with regard to technology and economic growth than projections out to 2050. This is reflected in the larger confidence interval around the mean at 2100 than at 2050 in graphs of these emissions scenarios (see Figure SPM–5 in IPCC 2007). However, GHG loading in the atmosphere has considerable lags in its response, so that what has already been emitted and what can be extrapolated to be emitted in the next 15–20 years will have impacts out to 2050 and beyond (IPCC 2007, p. 749; J. Overland, NOAA, in litt. to the Service, 2007). This is reflected in the similarity of low, medium, and high SRES emissions scenarios out to about 2050 (see discussion of climate change under ''Factor A. Present or Threatened Destruction, Modification, or Curtailment of the Species' Habitat or Range''). Thus, the uncertainty associated with emissions is lower for the foreseeable future timeframe (45 years) for the polar bear listing than longer timeframes.

Comment 29: Atmospheric CO_2 is an indicator of global warming and not a major contributor.

Our response: Carbon dioxide (CO_2) is one of four principal anthropogenically-generated GHGs, the others being nitrous oxide (N_2O), methane (CH_4), and halocarbons (IPCC 2007, p. 135). The IPCC AR4 considers CO_2 to be the most important anthropogenic GHG (IPCC 2007, p. 136). The GHGs affect climate by altering incoming solar radiation and out-going thermal radiation, and thus altering the energy balance of the Earth-atmosphere system. Since the start of the industrial era, the effect of increased GHG concentrations in the atmosphere has been widespread warming of the climate, with disproportionate warming in large areas of the Arctic (IPCC 2007, p. 37). A net result of this warming is a loss of sea ice, with notable reductions in Arctic sea ice.

Comment 30: Atmospheric CO_2 levels are not greater today than during pre-industrial time.

Our response: The best available scientific evidence unequivocally contradicts this comment. Atmospheric concentration of carbon dioxide (CO_2) has increased significantly during the post-industrial period based on information from polar ice core records dating back at least 650,000 years. The recent rate of change is also dramatic and unprecedented, with the increase documented in the last 20 years exceeding any increase documented over a thousand-year period in the historic record (IPCC AR4, p. 115). Specifically, the concentration of atmospheric CO_2 has increased from a pre-industrial value of about 280 ppm to 379 ppm in 2005, with an annual growth rate larger during the last 10 years than it has been since continuous direct atmospheric measurements began in 1960. These increases are largely due to global increases in GHG emissions and land use changes such as deforestation and burning (IPCC 2007, pp. 25–26).

Comment 31: Consider the impacts of black carbon (soot) due to increased shipping as a factor affecting the increase in the melting of the sea ice.

Our response: We recognize that there are large uncertainties about the contribution of soot to snow melt patterns. A general understanding is that soot (from black carbon aerosols) deposited on snow reduces the surface albedo with a resulting increase in snow melt process (IPCC 2007, p. 30). Estimates of the amount of effect from all sources of soot have wide variance, and the exact contribution from increased shipping cannot be determined at this time.

Comment 32: Climate models do not adequately address naturally occurring phenomena.